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<p>(21) International Application Number: PCT/GB97/02679 (22) International Filing Date: 29 September 1997 (29.09.97) (30) Priority Data: 9620824.4 5 October 1996 (05.10.96) GB</p> <p>(71) Applicant (<i>for GB IE only</i>): FORD MOTOR COMPANY LIMITED [GB/GB]; Eagle Way, Brentwood, Essex CM13 3BY (GB). (71) Applicant (<i>for DE only</i>): FORD WERKE AG [DE/DE]; Werk Kolin-Niehl, Henry Ford Strasse, Postfach 60 04 02, D-5000 Kolin 60 (DE). (71) Applicant (<i>for FR MC only</i>): FORD FRANCE S.A. [FR/FR]; B.O. 307, F-92506 Rueil-Malmaison Cedex (FR). (71) Applicant (<i>for all designated States except DE FR GB IE MC US</i>): FORD MOTOR COMPANY [US/US]; The American Road, Dearborn, MI 48126 (US). (72) Inventor; and (75) Inventor/Applicant (<i>for US only</i>): SMITH, Graeme, Peter [GB/GB]; 11 Clover Avenue, Bishops Stortford, Herts CM23 4BW (GB).</p>			
(54) Title: VEHICLE AIRBAG INFLATION CONTROL METHOD			
(57) Abstract			
<p>An airbag deployment system (1) comprising an airbag inflator (3) operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator (5), a sensing system (7) arranged to detect the presence of an object in a predetermined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit (9) which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator (5) to indicate the rate of inflation required for the optimum protection to be provided by the airbag. Typically the sensing system (7) is a radar sensing system.</p>			

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VEHICLE AIRBAG INFLATION CONTROL METHOD

Field of the Invention

- 5 The invention relates to an improved vehicle airbag deployment and inflation system.

Airbags are recognised as a major breakthrough in the protection of vehicle occupants in the event of collision.

- 10 Driver and passenger airbags are commonly used to protect the occupants of the front seat of a vehicle and further airbag applications are being proposed and introduced including side airbags and airbags for rear passengers.

- 15 Traditionally an airbag is actuated to operate on an impact being sensed. Mounted within a vehicle are impact sensors which sense when a collision has occurred to trigger deployment of the airbag. Sensors are now being developed which detect the position of an occupant and identify the
20 nature of the seat's occupant to allow the airbag actuator to be disabled in certain circumstances. These systems all depend upon the impact sensor within a vehicle operating after a collision has occurred to actuate the airbag.

- 25 Many airbags have been developed which have a variable rate of inflation depending upon the severity of impact, or the size and position of the occupant. In many cases the impact sensor detects the velocity of impact after a collision has occurred.

- 30 A number of radar systems have been proposed for installation in motor vehicles for detecting objects around a vehicle. Transmitters and receivers are mounted upon the vehicle to detect the presence or approach of objects in a
35 particular direction to be used to help to warn an occupant of a potential collision. Typically, such systems have been developed for collision warning and parking aids.

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Summary of the Invention

According to the invention there is provided an airbag deployment system comprising an airbag inflator operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator, a sensing system arranged to detect the presence of an object in a pre-determined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

Thus the invention encompasses a system where the method of sensing the presence of an object approaching the vehicle and potentially causing a collision may be radar sensing, or may for example use infrared or ultrasonic sensing.

However it is preferred that the method of sensing is radar sensing so that according to a preferred embodiment of the invention there is provided an improved airbag deployment system comprising an airbag inflator operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator, a radar sensing system including at least one radar transmitter and receiver arranged to detect the presence of an object in a pre-determined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

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Thus as soon as impact is sensed the airbag inflation can be initiated so that there are no delays in the airbags operation.

5 The predetermined area in relation to the vehicle in which the presence of an object is to be detected depends on the nature of the airbag to be deployed. The driver and passenger airbags will operate in different collision conditions than a side airbag, for example.

10 Preferably the system includes at least two radar transmitters and receivers, which are impulse radar transmitters and receivers. In the specification, the term 'impulse radar' is intended to encompass any radar signal of
15 short radio frequency without a carrier wave, and includes radar sometimes referred to as 'broadband radar'. A typical impulse radar sensor is described in published WO90/13048. Such a system can be used to track accurately the path of an object outside the vehicle to accurately predict the
20 potential of a collision, its likely position and time before impact.

Although the radar sensing system may be used in a vehicle, purely for use in the airbag deployment system, the
25 invention is applicable with particular advantage to a vehicle in which the radar sensing system is used also for providing driver information and warnings, such as a parking aid. The advantage is that the same sensors are multifunctional. Preferably the radar sensing system is part
30 of a multifunctional system as described in copending application GB97/01728. Such a system is able to look around the vehicle to detect obstacles about the vehicle and to use the signals detected in a number of collision warning modes.

35 Preferably the airbag deployment system also includes a pre-arming mechanism as described in our co-pending patent application filed on the same date and entitled

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'Improvements relating to Vehicle Airbag Deployment'. In such a system the pre-arm mechanism, coupled to the airbag actuator, comprises a pre-arm control system coupled to the radar sensing system which pre-arms the airbag actuator in 5 readiness for an impact detected by the impact sensor of the airbag deployment system.

In such a system, in theory it would be possible for the airbag actuator to be disabled until a potential collision 10 signal has been received by the pre-arm control system. However, such a system would require an override to be included in the event of a collision occurring due to impact with an object from a position outside the predetermined area scanned by the radar transmitter or receiver.

15 Preferably however the airbag actuator has two stages in its operation, a pre-arm stage, where the airbag state is changed from non operating to a ready to fill mode, and an actuation stage where the release of the gas to fill the 20 airbag is initiated. The use of the two stages means that the second actuation stage can be made quicker, to reduce the time between impact and the airbag protection being available.

25 Brief Description of the Drawings

An airbag deployment system in accordance with the invention will now be described, by way of example only, with 30 reference to the accompanying drawings, in which:-

Figure 1 is a schematic block diagram of the airbag deployment system;

35 Figure 2 is a schematic view of the predetermined area scanned by the radar receiver; and,

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Figure 3 is a schematic plan view of a vehicle illustrating the position of the sensors and receivers.

Description of the Preferred Embodiment

5

The airbag deployment system 1 illustrated in the drawings comprises an airbag inflator 3 operable to inflate the airbag (not shown) at a variable rate dependant upon a signal from an airbag actuator 5, a radar sensing system 7 including at least one radar transmitter and receiver arranged to detect the presence of an object in a predetermined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit 9 which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator 5 to indicate the rate of inflation required for the optimum protection to be provided by the airbag.

20 An impact sensor 11 senses when the impact occurs and then causes the actuator 5 to operate the inflator 3 at the rate already calculated. The impact sensor 11 is standard, the choice of which will be apparent to the skilled addressee of the specification.

25

Preferably the collision prediction unit 9 also acts as a pre-arm mechanism. On receipt of a signal indicating a likely collision occurrence the collision prediction unit 9 sends a pre-arm signal to the actuator so that it is pre-30 armed and primed for operation on sensing that collision has occurred.

35 The airbag actuator is non standard since it has three operating modes, one putting the airbag mechanism into standby, pre-armed mode ready for impact, the second to initiate operation and the third for controlling the inflation rate.

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The radar system 7 comprises four sensors 13 shown in figure 3 mounted at the corners of the vehicle in the region of the bumper. Each sensor 13 comprises an impulse radar
5 transmitter and receiver. This arrangement of four sensors allows the envelope around the vehicle to be monitored. The predetermined areas which need to be monitored for actuation of side airbags, and for driver and passenger airbags are shown in figure 2.

10 The radar sensing system monitors continually the zones of concern illustrated in figure 2 for intrusion by other vehicles or other obstacles. The predetermined areas are front of vehicle, rear of vehicle, drivers side and
15 passenger side. The sensors 13 are used in pairs to track the trajectory of targets within their field of view. Time to impact is calculated using knowledge of relative velocities of the vehicle and target. If it is determined that a collision greater than a predetermined threshold
20 speed is highly likely given the current dynamics of the situation, and the current driver actions, then a trigger signal (the pre-arm signal) is given to the airbag actuator to arm it in preparation for impact. The collision prediction unit also feeds a signal to the actuator to
25 ensure that on inflation, the rate of inflation will be optimal.

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Claims

1. An airbag deployment system 1 comprising an airbag inflator 3 operable to inflate the airbag at a variable rate dependant upon a signal from an airbag actuator 5, a sensing system 7 arranged to detect the presence of an object in a pre-determined area relative to the vehicle and to detect the velocity and direction of movement of the object relative to the vehicle, and feeds this information to a collision prediction unit 9 which calculates the impact velocity of the impending collision, and feeds a signal to the airbag actuator 5 to indicate the rate of inflation required for the optimum protection to be provided by the airbag.
- 15 2. A system according to claim 1, in which the sensing system 7 is a radar sensing system.
- 20 3. A system according to claim 2, in which the sensing system includes at least two impulse radar transmitters and receivers.
- 25 4. A system according to any one of the preceding claims, in which the sensing system 7 is used also for providing driver information and warnings.
- 30 5. A system according to any one of the preceding claims, in which the system also includes an impact sensor 11 coupled to the airbag actuator 5, an airbag pre-arm mechanism, coupled to the airbag actuator 5, which comprises a pre-arm control system coupled to the sensing system which pre-arms the airbag actuator in readiness for an impact detected by the impact sensor 11 of the airbag deployment system.
- 35 6. A system according to claim 5, in which the airbag actuator has two stages in its operation, a pre-arm stage, where the airbag state is changed from non operating to a

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ready to fill mode, and an actuation stage where the release of the gas to fill the airbag is initiated.

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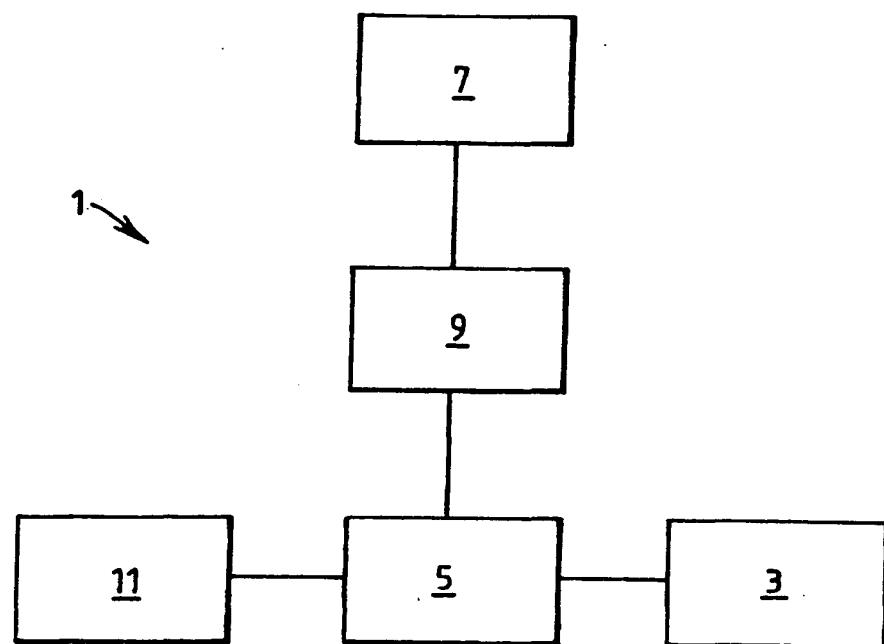


FIG.1

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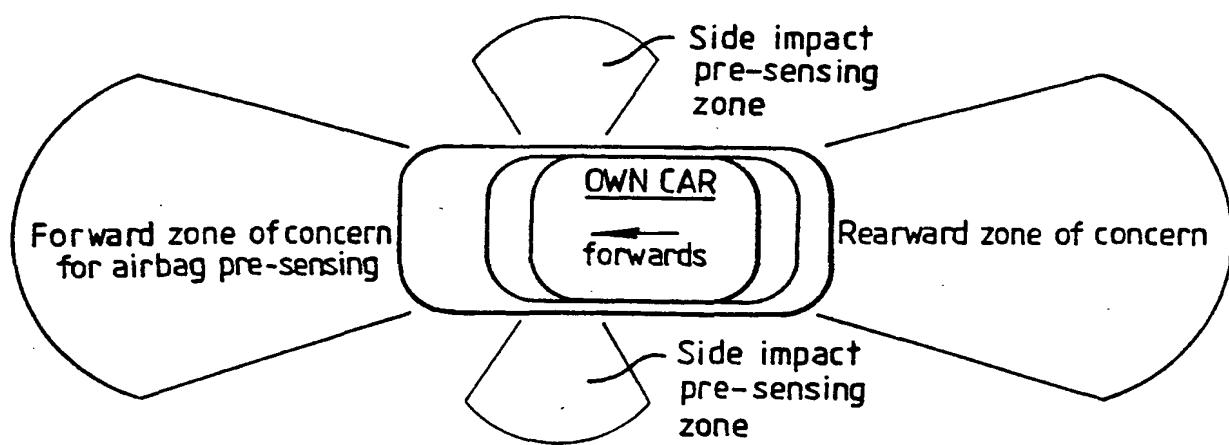


FIG. 2

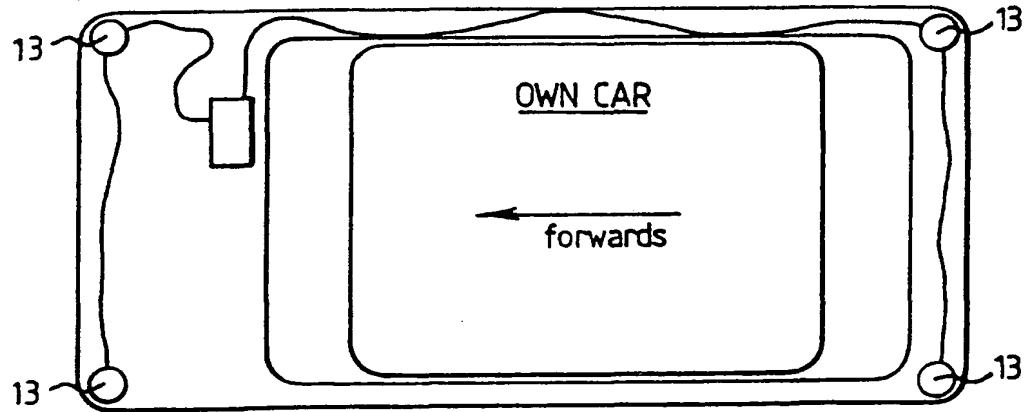


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 97/02679

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60R21/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60R GO1S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 44 26 090 A (TELEFUNKEN MICROELECTRON) 20 July 1995 see column 1, line 58-62	1,2
Y	see column 3, line 5-26 see column 4, line 11-15	3-6
X	GB 2 289 786 A (AUTOMOTIVE TECH INT) 29 November 1995	1,2
Y	see page 4, line 23 - page 5, line 10 see page 14, line 2-5 see page 15, line 11-13	3-6
Y	DE 44 24 878 A (TEMIC BAYERN CHEM AIRBAG GMBH) 18 January 1996 see column 2, line 16-28	3
Y	DE 36 37 165 A (ASHAUER RAINER) 5 May 1988 see column 10, line 46-64	4
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Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 285 188 A (YOSHIDA RYOUICHI) 8 February 1994 see the whole document -----	5, 6
Y	US 3 851 305 A (BABA K ET AL) 26 November 1974 see column 3, line 49 - column 4, line 43; figures 1,10 -----	5, 6
A	DE 43 45 185 A (MUELLER FRANZ DIPL ING FH) 1 December 1994 see column 2, line 2-11; claim 1 -----	1
A	US 5 285 207 A (ASBURY JIMMIE ET AL) 8 February 1994 see column 1, line 16-32 see column 17, line 26-39 -----	3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 97/02679

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE 4426090 A	20-07-95	NONE		
GB 2289786 A	29-11-95	JP 8198044 A		06-08-96
DE 4424878 A	18-01-96	NONE		
DE 3637165 A	05-05-88	NONE		
US 5285188 A	08-02-94	JP 4361163 A		14-12-92
US 3851305 A	26-11-74	DE 2225709 A FR 2139944 A GB 1388636 A		28-12-72 12-01-73 26-03-75
DE 4345185 A	01-12-94	DE 4323543 C AU 6374194 A DE 4491867 D WO 9422692 A DE 59403254 D EP 0691910 A		06-10-94 24-10-94 27-06-96 13-10-94 07-08-97 17-01-96
US 5285207 A	08-02-94	US 5189426 A US 5400032 A US 5510794 A AU 668874 B AU 2247292 A AU 6422796 A BR 9205972 A CA 2102101 A EP 0583418 A JP 5508479 T WO 9219980 A US 5181038 A		23-02-93 21-03-95 23-04-96 23-05-96 21-12-92 24-10-96 02-08-94 07-11-92 23-02-94 25-11-93 12-11-92 19-01-93

